Radiologic Analysis of Surgically Treated Fractures of the Condylar Process by an Endoscopic-Assisted Transoral Approach

Blumer, Michael ; Wagner, Maximilian Eberhard ; Rücker, Martin ; Lanzer, Martin ; Essig, Harald ; Gander, Thomas

Abstract: PURPOSE This study analyzed the radiologic outcomes of patients with unilateral mandibular condylar fractures treated with open reduction-internal fixation (ORIF) through a transoral approach. PATIENTS AND METHODS In this retrospective study, the radiologic images of 40 patients who underwent open reduction-internal fixation through a transoral approach were presented to 2 independent examiners. All patients underwent the surgical procedure between January 2015 and December 2016 at the Department of Cranio-Maxillofacial Surgery at UniversitätsSpital Zürich and were included in a previous functional outcome study. The surgical results were analyzed and graded as poor, acceptable, or good. The examiners declared whether they would have made any intraoperative revisions if the radiologic information had been available. Finally, the examiners estimated the required duration of elastic intermaxillary fixation (IMF) from the radiologic images, which was compared with the actual duration. RESULTS Fracture reduction was classified as good in 33 cases (82.5%), acceptable in 5 cases, and poor in 2 cases by one examiner and as good in 32 cases (80%), acceptable in 6 cases, and poor in 2 cases by the other examiner. The inter-rater reliability was determined to be good (Cohen κ = 0.92). Correct osteosynthesis placement was found in 19 cases by one examiner and in 21 cases by the other examiner, with good inter-rater reliability (κ = 0.8). Moderate inter-rater reliability (κ = 0.4) was found for the required duration of elastic IMF. Furthermore, the estimated elastic IMF duration matched the actual duration in fewer than half of the cases. CONCLUSIONS It is feasible to achieve reliably good radiologic results when operating on condylar process fractures by a transoral approach with endoscopic assistance and angled instruments. Intraoperative 3-dimensional imaging enables instant quality control and prompts surgical revision if needed.

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Radiological analysis of surgically treated fractures of the condylar process by an endoscopic-assisted transoral approach

Michael Blumer, Dr. med. Dr. med. dent.[1)], Maximilian Eberhard Wagner, Dr. med. univ. Dr. med. dent.[1)], Martin Rücker, Prof. Dr. med. Dr. med. dent.[2)], Martin Lanzer, Dr. med. Dr. med. dent.[1)], Harald Essig, PD Dr. med. Dr. med. dent.[1)], Thomas Gander, PD Dr. med. Dr. med. dent.[1)]

[1)] Fellow, Clinic for Cranio-Maxillofacial Surgery, University Hospital, Zurich, Switzerland

[2)] Professor and Medical Director, Clinic for Cranio-Maxillofacial Surgery, University Hospital, Zurich, Switzerland

Corresponding author:

Michael Blumer
Dr. med. Dr. med. dent.
Klinik für Mund-, Kiefer- und Gesichtschirurgie
+41 43 253 95 75
Michael.Blumer@usz.ch

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Abstract

Purpose

This study analyzed the radiological outcomes of patients with unilateral mandibular condyle fractures, who were treated with open reduction and internal fixation (ORIF) through a transoral approach.

Methods:

In this retrospective study, radiological images of 40 patients, who underwent ORIF through a transoral approach, were presented to two independent examiners. All patients underwent the surgical procedure between January 2015 and December 2016 at the Department for Cranio-Maxillofacial Surgery at the UniversitätsSpital Zürich, and were included in a forgoing functional outcome study. The surgical results were analyzed and graded as poor, acceptable, or good. The examiners declared if they would have made any intraoperative revisions if the radiological information had been available. Finally, the examiners estimated the required duration of elastic mandibulomaxillary fixation (MMF) from the radiologic images, which was compared to the actual duration.

Results:

Fracture reduction was classified as good in 33 (82.5%) cases, acceptable in 5 cases, and poor in 2 cases by one examiner, and as good in 32 (80%) cases, acceptable in 6 cases, and poor in 2 cases by the other examiner. The interrater reliability was determined to be good (Cohen's $\kappa = 0.92$). Correct placement of osteosynthesis was found in 19 cases by one examiner and in 21 cases by the other examiner, with a good interrater reliability ($\kappa = 0.8$).

A moderate interrater reliability ($\kappa = 0.4$) was found for the required duration of elastic MMF. Furthermore, the estimated elastic MMF duration matched the actual duration in fewer than half of the cases.

Conclusion:

It is feasible to achieve reliably good radiological results when operating on condylar process fractures by a transoral approach with endoscopic assistance and angled instruments.

Intraoperative three-dimensional imaging enables instant quality control and prompts surgical revision if needed.

Introduction

Condylar process fractures are common, accounting for 25 – 35 % of all mandible fractures [1, 2]. As the etiology is often indirect trauma [3], these fractures can be missed without proper three-dimensional (3D) imaging. Sequelae of closed treatment may include malocclusion, pain, loss of vertical height, and arthritis [4]. Recent meta-analyses appear to favor open reduction and internal fixation (ORIF) for condylar process fractures [5, 6], especially in dentate patients with dislocated or displaced fractures.

Through a strict transoral approach, an ORIF with angled instruments and endoscopic assistance is feasible and shows good clinical results [7]. The endoscope increases visibility and angled instruments make the transbuccal approach redundant, which minimizes scarring and the risk of facial nerve palsy [8, 9].

Intraoperative imaging is gaining importance as a tool for immediate feedback, which allows the revision of unfavorable results [10-12]. This could be an important ameliorating factor when the operating technique is demanding, and the visibility of the operative field is low. While elastic (semirigid) mandibulomaxillary fixation (MMF) may be implemented after ORIF of condylar fractures, there is a lack of literature on this procedure.

This retrospective study analyzes radiological outcomes of patients with unilateral mandibular condyle fractures who have been treated by ORIF through a transoral approach. The surgeon's intention to revise intraoperatively was analyzed by two independent examiners, as was the duration of postoperative elastic MMF.

Methods

The clinic information system of the Department for Cranio-Maxillofacial Surgery at the UniversitätsSpital Zürich was searched for patients with unilateral extracapsular mandibular

condyle fractures, that were treated using endoscopic-assisted ORIF through a strict transoral approach between January 2015 and December 2016. All patients had to be dentate to control for any occlusion, and had been included in a forgoing study on clinical postoperative outcome [7]. The radiological results of the ORIF were displayed as postoperative 3D images (either computed tomography [CT] or cone-beam CT) in the coronal and parasagittal planes. Two examiners (consultants with more than 5 years of clinical experience) classified the operative reduction results as poor, acceptable, or good. Furthermore, they indicated whether they would have revised the internal fixation before wound closure if radiological images had been available intraoperatively. Additionally, they had to estimate how long postoperative elastic MMF should be applied (< 1 week, 1 – 2 weeks, or > 2 weeks). The interrater reliability was analyzed using Cohen's κ, and the estimated duration of MMF was compared to the actual duration.

Informed consent was obtained from all participating patients, as was ethical approval from the responsible ethics committee at KEK Zürich (file sign: 2015-0423). The study design thereby fulfilled the guidelines of the Declaration of Helsinki regarding ethical principles for medical research involving human subjects.

Statistical analyses were performed using Excel software (Microsoft Corporation, Redmond, USA) and the R software (R Foundation, Wien, Austria). A *P* value of < 0.05 was considered statistically significant.

Radiological evaluation:

The clinical Picture Archiving and Communication System was searched, and software such as Synedra View (Synedra Information Technologies GmbH, Innsbruck, Austria) and ICIS View (Agfa HealthCare, Agfa-Gevaert, Mortsel, Belgium) was used.

Results

The clinical outcomes have been previously reported [7]. A total of 40 patients (29 males, 11 females), with a mean age of 34 years (median: 30 years, range 16 to 79 years) were included.

The majority of the fractures was caused by falls from 3 meters or less. Other causes, in decreasing frequency of occurrence, were incidents of violence, bicycle accidents, and sport injuries [7]. Examiner 1 classified 33 (82.5%) reductions as good (Figure 1), 5 as acceptable, and 2 as poor (Figure 2). Examiner 2 rated 32 (80%) reductions as good, 6 as acceptable, and 2 as poor (Table 1). The Cohen's κ was 0.92. Both examiners would have revised the same 2 cases if they had intraoperative imaging ($P < 0.005$).

The analysis of the angle between two plates showed a Cohen's κ interrater reliability of 0.8. As only one plate could be fixed among a total of eight cases, all of these cases were rated as having an incorrect placement. Examiner 1 rated 19 cases as correct, whereas Examiner 2 rated 21 as correct ($P < 0.005$). The interrater reliability of their estimation of the required duration for elastic MMF was moderate (Cohen's $\kappa = 0.4$). For Examiner 1, the estimated duration of elastic MMF matched the actual duration in 14 cases (a shorter period was estimated in 18 cases, and a longer period was estimated in 8 cases). For Examiner 2, the estimated duration was accurate in 19 cases (a shorter period was estimated in 12 cases, and a longer period was estimated in 9 cases) (Table 2).

Discussion

The radiological results for ORIF of condylar process fractures using an endoscopic-assisted transoral approach were evaluated by two independent examiners in this study. Further, the intention to revise such surgical results intraoperatively was analyzed, thus illustrating the effectiveness of intraoperative 3D imaging.

The postoperative outcomes of the patients in the forgoing study were determined to be good, and no revisional surgery was required [7]. In the present study two cases, rated as having a poor reduction, would have been revised intraoperatively by both examiners. Interestingly, ideal osteosynthesis placement was rated differently. Nevertheless, both patients had a prolonged MMF over 2 weeks, even though no postoperative malocclusion or impaired mouth opening was observed.

An intraoperative revision would have been prompted in two cases if 3D intraoperative imaging had been available. Even though this would not have led to an improved clinical outcome in the long term, both examiners would have revised the same cases, reflecting a good interrater correlation, according to Landis and Koch [13].

Intraoperative imaging is important for quality control, and a recent study on intraoperative 3D imaging in tibial plateau fracture surgery showed a high intraoperative revision rate (26.5% of 559 cases) due to insufficient reduction or osteosynthesis placement [14]. Another study revealed a 35% revision rate in facial fracture surgeries, when using intraoperative 3D C-arm imaging. Following an analysis of the costs, the authors concluded that while postoperative CT imaging is equal in price, intraoperative imaging is more cost-effective, as it ensures proper fracture reduction and lowers the risk of suboptimal surgical results [15].

In the present study, cases with an acceptable reduction also had a good interrater correlation (5 vs 6 cases). Although these surgical cases appeared to be demanding (e.g., short fracture fragment, unfavorable fracture line) and the radiological results were not optimal, neither of the examiners stated that they would have revised these cases intraoperatively, due to the possibility that revision could have caused more harm or resulted in uncertain clinical outcomes.

Only a moderate interrater correlation could be found for the estimated elastic MMF. In many cases, surgeons use elastic MMF when (1) osteosynthesis is suboptimal; (2) intraoperative occlusion is poor; or (3) the patient is thought to be incompliant, and movement and loading may result in an instable osteosynthesis. The actual duration of postoperative elastic MMF depends on the patient's occlusion. Therefore, estimating the required time for MMF, from radiological data alone, is challenging. In this study, a moderate match was observed for the estimated and actual elastic MMF duration, and the examiners seemed to favor a longer elastic MMF duration in cases with only one plate. Nevertheless, to the best of our knowledge, no studies have been conducted on the benefits of longer MMF use in such cases. Furthermore, it must be noted that we currently tend not to use elastic MMF in cases

with good intraoperative occlusion and stable surgical osteosynthesis, in order to support early functional rehabilitation [16].

Ideally, in order to obtain the maximum benefit from ORIF through a transoral approach, no MMF is applied. Exceptions may include cases with a poor intraoperative occlusion, patient non-compliance, and a lack of rigid surgical osteosynthesis (e.g., single plate osteosynthesis or poor bone quality). In cases requiring MMF, the duration should be as short as possible, as a MMF duration over 2 weeks could be counterproductive to early functional recovery. Furthermore, the experience of the surgeon is a major determinant of the treatment outcome; a high level of experience is required for dual plate osteosynthesis (which is more reliable than single plate osteosynthesis) in cases with a short proximal fragment.

A limitation of this study included the use of a retrospective design and a small sample size as also mentioned in the forgoing study [7]; however, these factors also facilitated the feasibility of conducting analyses on the radiological features. It is possible to achieve reliably good radiological results when operating on condylar process fractures by a transoral approach with endoscopic assistance and angled instruments. More than 80% of the fracture reductions were rated as good by two independent and experienced examiners, reflecting a good interrater reliability. Intraoperative 3D imaging enables instant quality control and therefore prompts surgical revision if required; however, the added value to postoperative clinical improvement is uncertain. Further prospective studies, utilizing larger sample sizes, are required to evaluate the utility of intraoperative imaging as a surgical tool when treating condylar fractures.

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Tables

Table 1: Analysis of the operative reduction outcomes by two independent examiners

Surgical reduction results	**Examiner 1**	**Examiner 2**
Good	33	32
Acceptable	5	6
Poor	2	2

Table 2: Analysis of the actual and estimated duration of mandibulomaxillary fixation by the two examiners

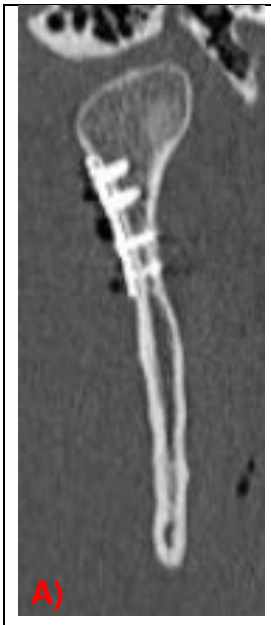
		Examiner 1 Estimated duration			**Examiner 2 Estimated duration**		
		< 1 week	1 - 2 weeks	> 2 weeks	< 1 week	1 - 2 weeks	> 2 weeks
Actual MMF duration	< 1 week	6	1	2	5	2	2
	1 - 2 weeks	8	1	5	5	4	5
	> 2 weeks	6	4	7	5	2	10

MMF = mandibulomaxillary fixation

Figure legends

Fig. 1: (A) Coronal and (B) parasagittal planes of a surgically treated right condyle fracture. The reduction and plate placement were classified as good. (C) (D) Endoscopic photographs of the surgically reduced right condyle fracture.

Fig. 2: (A) Coronal and (B) parasagittal planes of a surgically treated left condyle fracture. The reduction and plate placement were rated as poor. (C) (D) Endoscopic photographs of the surgically reduced left condyle fracture show the poor plate placement and reduction.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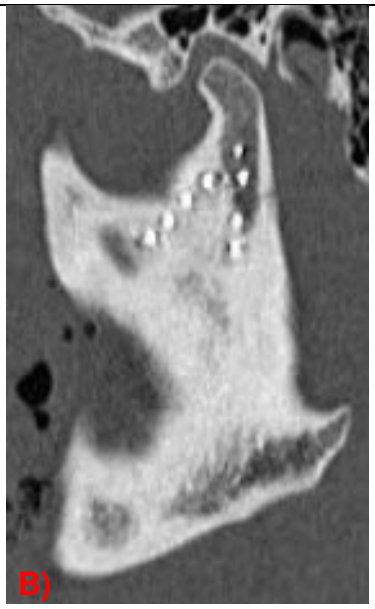
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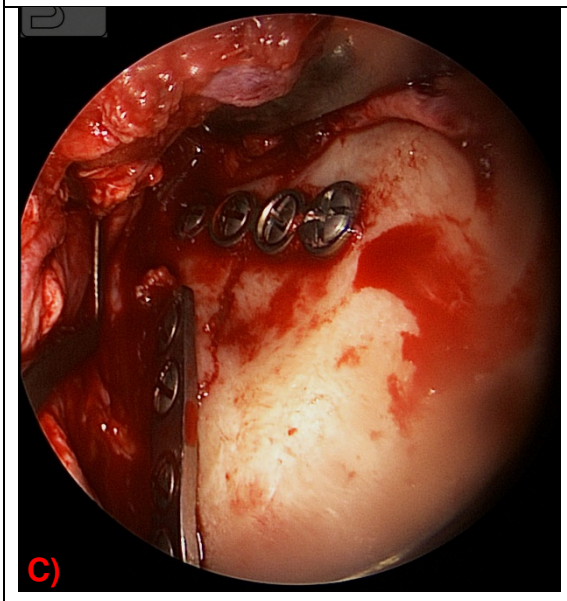
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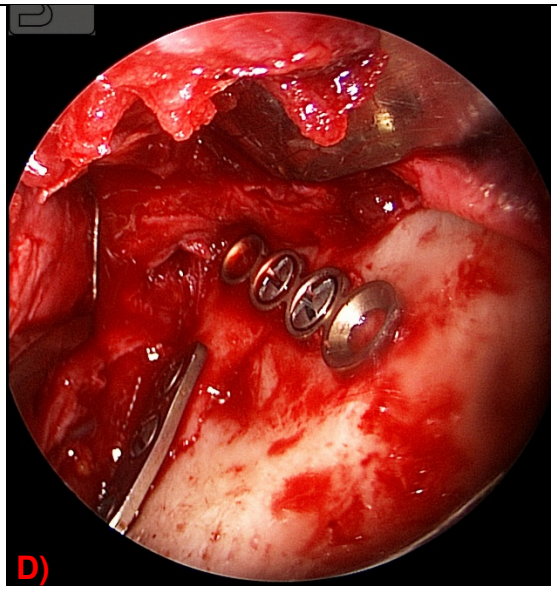
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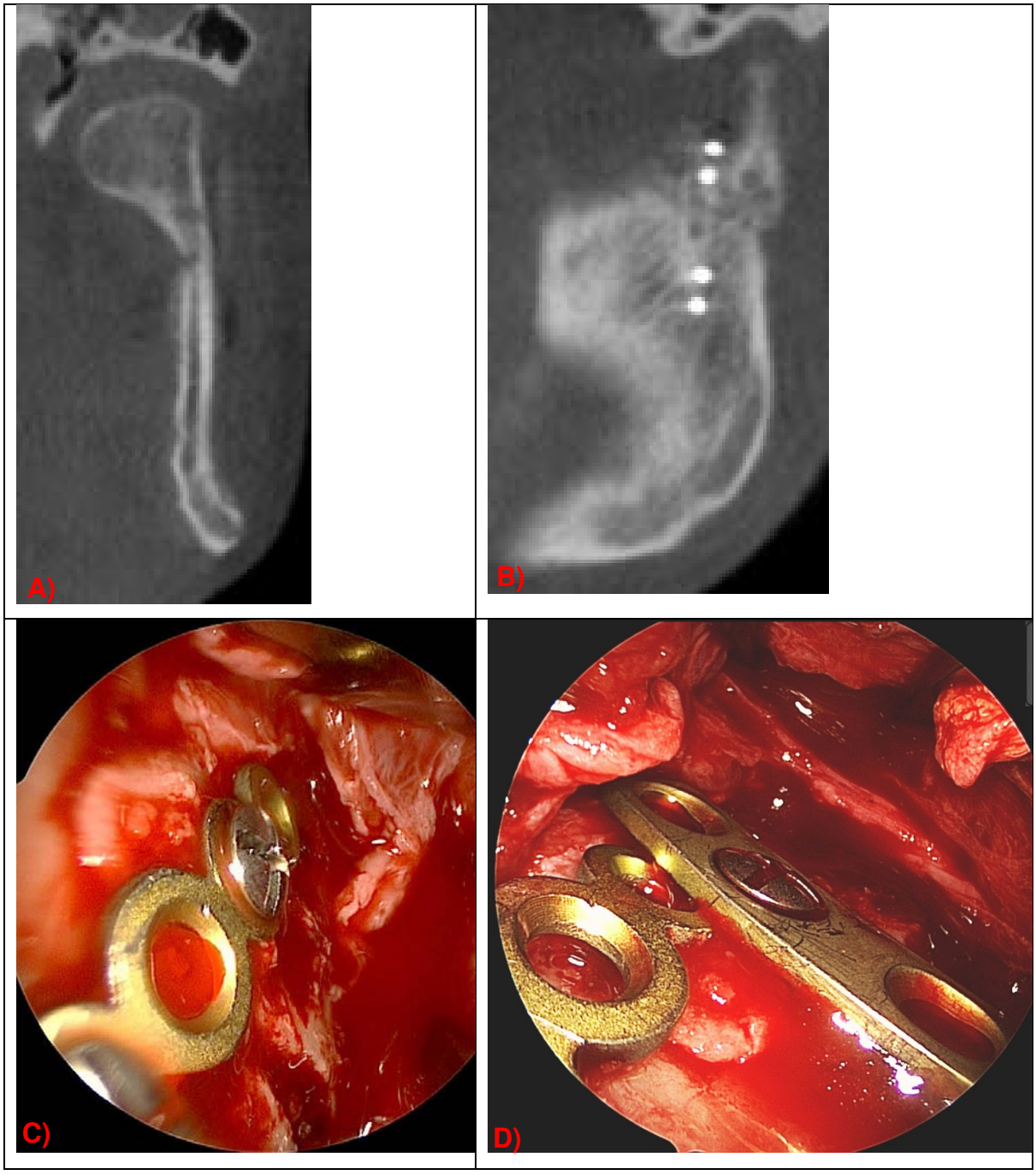
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